

Environmental Monitoring Report on the U.S. Department of Energy's Inactive Millsite Facility, Monticello, Utah, for Calendar Year 1987

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1987 ENVIRONMENTAL MONITORING REPORT ON DOE
FACILITY AT MONTICELLO, UTAH - CY 1987 5/88



Grand Junction
Projects Office

May 1988

I n f o r m a l R e p o r t

**ENVIRONMENTAL MONITORING REPORT
ON THE U.S. DEPARTMENT OF ENERGY'S
INACTIVE MILLSITE FACILITY,
MONTICELLO, UTAH, FOR
CALENDAR YEAR 1987**

**The U.S. Department of Energy
Grand Junction Projects Office
Idaho Operations Office**

May 1988

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SUMMARY

The inactive Monticello Millsite is located in San Juan County, Utah, just south of the town of Monticello. Environmental monitoring at the site is funded by the Surplus Facilities Management Program (SFMP) and focuses on releases due to preexistent mill tailings. All contaminant discharges result from the leaching of uranium-mill-tailings-related elements by ground water and surface water, and from the release of radon gas and particulate matter into the atmosphere. Pathways facilitating the migration of contaminants from the Monticello site include ground water in the shallow alluvial aquifer underlying the inactive facility, surface water running across the site, and the surrounding atmosphere.

The shallow aquifer underlying the Monticello property is contaminated as a result of uranium mill tailings. Concentrations of uranium, molybdenum, vanadium, selenium, and arsenic exceed 1 milligram per liter (mg/l) in some wells. Montezuma Creek, which flows through the property, has frequently contained contamination at levels exceeding State of Utah water-quality standards for 3-5 kilometers (2-3 miles) downstream of the property. Contamination of the creek results from seeps issuing from the contaminated alluvial aquifer. This seepage has, in the past, caused the uranium concentration in the creek to increase by as much as an order of magnitude; concentrations as high as 0.9 mg/l were detected 30 meters (100 feet) downstream of the Government property in 1984. During 1985, 1986, and 1987, observed concentrations of uranium, selenium, and molybdenum were lower; however, fewer samples were collected than in previous years and samples were collected when water in the creek was at relatively high levels, which diluted the contaminants. Montezuma Creek is used for both irrigation and livestock watering in the vicinity of the site.

Extensive measurement of radon contamination from the tailings piles was conducted during 1984, 1985, and to a lesser extent during 1986 and 1987. On-pile, site-boundary, and off-site atmospheric radon measurements, as well as on- and off-pile radon-flux measurements, were taken. Results of these measurements demonstrate that the EPA standard for radon emissions from inactive uranium processing sites is exceeded at all four tailings piles at the Monticello site.

Air particulate monitoring was conducted during 1987 at two on-site locations and at one background location using high-volume Sierra-Anderson model 300 air particulate samplers. So that only the inhalable particles would be collected, 10-micron-size screens were added to the samplers. The maximum airborne concentrations of radium-226, thorium-230, and uranium were all several orders of magnitude below the regulatory limits specified by DOE Order 5480.1.

INTRODUCTION

This report presents results of environmental monitoring activities conducted in 1987 at the inactive uranium millsite in Monticello, Utah. The site is included under the U.S. Department of Energy's (DOE) Surplus Facilities Management Program (SFMP). Monitoring and report preparation were the responsibility of UNC Geotech, the DOE contractor for the Grand Junction Projects Office Facility (GJPO) in Grand Junction, Colorado.

The Monticello Millsite is a 31.6-hectare (78-acre) tract located in San Juan County, Utah, adjacent to the city limits of Monticello. The mill area covers approximately 4 hectares (10 acres), the tailings impoundment area covers the remaining 27.5 hectares (68 acres). None of the original mill buildings remain, but contaminated foundations and scrap materials are buried on site. The tailings impoundment area contains almost 1,814,000 metric tons (2 million short tons), or 1,018,800 cubic meters (1,333,333 cubic yards), of tailings and contaminated soil in four discrete piles. An additional 362,800 metric tons (400,000 short tons), or 203,759 cubic meters (266,666 cubic yards), of contaminated material is present on adjacent open lands (Marutzky and others, 1985).

Prior to 1955, the environmental problems receiving attention at the Monticello mill arose from the salt roast procedure used to enhance vanadium recovery. An average of nearly 1182 kilograms (2600 pounds) of dust containing 0.363 percent U_3O_8 and 1.52 percent V_2O_5 escaped daily through the roaster stack (Allen and Klemenic, 1954). Corrosion of wire fences, clotheslines, and galvanized roofs was verified by the mill operator in response to complaints from local residents.

Liquid effluent from the salt roast/carbonate leach plant, which contained substantial concentrations of chloride, sulfate, carbonate, bicarbonate, sodium, and other dissolved species, was released into Montezuma Creek. Release of radium-226 was of special concern; soluble radium activity in Montezuma Creek was found to be 160 picocuries per liter (pCi/l). It was also recognized that the suspended solids contained considerable radium activity and that dry tailings were being washed into the creek (Whitman and Beverly, 1958).

During milling operations, the tailings were normally moist so that erosion by wind was minimal. Within a year after shutdown, however, the tailings dams and surfaces of the piles dried out, and tailings sand began to migrate as dunes. Erosion by water also became a problem. Several cleanup activities conducted since the time of mill closure have substantially stabilized the area but have not eliminated water contamination. Extensive studies conducted at Monticello demonstrate that all four tailings piles contribute to the contamination of ground water and surface water, both on and off site.

Responsibility for administration, maintenance, and environmental monitoring of the inactive uranium millsite and tailings area at Monticello, Utah, formerly operated by the Atomic Energy Commission, resides with the DOE's GJPO. The site was accepted into the SFMP in 1980. Under this program, the chief objective of the Monticello Remedial Action Project is to minimize potential health hazards to the public that are associated with the tailings

at the millsite. In order to provide a basis for making decisions regarding the remediation of the site, an environmental and engineering characterization was completed and documented in the *Monticello Remedial Action Project Site Analysis Report* (Abramiuk and others, 1984). In addition, a Draft Remedial Investigation/Feasibility Study (RI/FS) report and a Draft Environmental Assessment (EA) report were completed in January 1988 (UNC Geotech, 1988a and b).

Previous years of monitoring activity at the Monticello Millsite have clearly defined the contaminant type and distribution in ground water, surface water, and air. Because of the well-defined plume characteristics at the site, monitoring activities were modified in 1987 to include biannual ground-water and surface-water samplings. Analyses were performed for known contaminants for which standards either exist or are proposed, i.e., gross alpha, radium-226, radium-228, uranium, vanadium, arsenic, selenium, molybdenum, and nitrate. Total alkalinity, pH, and specific conductance were measured as well to identify any change in the general water-quality characteristics. Ambient air monitoring at the site was conducted as in previous years.

ENVIRONMENTAL MONITORING PROGRAM

REGULATIONS REQUIRING MONITORING

Monitoring activities at the Monticello Millsite, a Superfund site, are conducted in conjunction with planned remediation activities under CERCLA/SARA. The resultant data will provide extensive baseline information prior to initiation of remediation. A review is presently underway to evaluate whether or not the Monticello site will be included on the NPL.

QUALITY ASSURANCE

Quality Assurance (QA) measures were incorporated into all of the monitoring activities detailed in this report, and were appropriately documented. General quality assurance policy and procedures, as presented in the *Quality Assurance Manual* (UNC Geotech/Grand Junction Projects Office 1987a), were followed. Other documents consulted to address QA considerations regarding specific measurement and sample-collection procedures were

- DOE/GJPO *Handbook of Analytical and Sample-Preparation Methods* (UNC Geotech, 1987b);
- DOE/GJPO *Administrative Plan and Quality Control Methods for the UNC/GJPO Analytical Laboratories* (UNC Geotech, 1988c);
- UNC/GJPO *Environmental Sciences Procedure Manual*, Second Edition (UNC Geotech, 1986); and
- SFMP/Monticello Remedial Action Project (MRAP) Quality Assurance Program Plan (QAPP) (UNC Geotech, 1987c).

SOURCES OF CONTAMINATION

Radioactive mill tailings compose the principal waste type at the Monticello millsite. Residual uranium ore at old ore stockpile areas at the millsite constitutes only a minor waste type. Historically, environmental concern has focused on the radiological hazards associated with the tailings and ore. However, a number of trace elements typically occur at elevated concentrations in uranium ore. These are not recovered during milling operations, but are passed through the circuit to the tailings piles. Because hazardous organic chemicals were not used in the milling process, the hazardous substances selected for waste characterization are all inorganic.

According to Albrethsen and McGinley (1982), 819,291 metric tons (903,298 short tons) of uranium ore was processed at the Monticello mill between 1948 and 1960 to yield approximately 2077 metric tons (2290 short tons) of uranium oxide, U_3O_8 , and 1061 metric tons (1170 short tons) of vanadium pentoxide, V_2O_5 . Most of the original constituents of the ore, as well as the chemicals added during the milling process, reside in the tailings. Therefore, the tailings quantity is estimated to be about 819,021 metric tons (903,000 short tons), or 459,988 cubic meters (602,000 cubic yards).

The tailings generated by the operations are contained in four piles referred to, in order of their construction, as the Carbonate Pile, Vanadium Pile, Acid Pile, and the East Pile (Figure 1). The Carbonate and Vanadium Piles were formed during the period from 1949 to 1955 when the mill was recovering vanadium as a by-product. The process used for the recovery was a salt roast/carbonate leach flow sheet. The Vanadium Pile is so called because of the high vanadium content of these tailings; it is in no way related to tailings produced by the Vanadium Corporation of America (VCA) mill that preceded the Atomic Energy Commission (AEC) mill. Use of the Acid Pile commenced about 1955. This pile received tailings from the acid leach RIP process and a carbonate leach circuit. The East Pile was operated from 1956 until mill shutdown in 1960 and received tailings from the acid leach circuit and the high temperature, carbonate leach RIP circuit.

Photographs taken during the operation of the millsite indicate that earthen berms were initially used to impound the tailings. As the impoundment filled, sandy tailings were apparently used as berm material to maintain the ponds. After closure of the mill, the piles were regraded and stabilized by covering them with pit-run gravel and top soil. The total quantity of tailings, earthen berms, cover material, and contaminated substrate is estimated to be about 1,451,790 cubic meters (1.9 million cubic yards). Materials from all four tailings piles are available for leaching into the ground and surface water and for release into the atmosphere.

GROUND WATER

Hydrogeology

There are two primary aquifers in the project area. Unconsolidated materials deposited by Montezuma Creek constitute an alluvial aquifer along the valley bottom. An underlying sandstone aquifer, the Burro Canyon Formation, is separated from the alluvial aquifer by the Mancos Shale and by shale units of the Dakota Sandstone, which act as a major aquitard in the project area (Figure 2).

The alluvial aquifer is approximately 3 meters (15 feet) thick near Montezuma Creek and thins gradually toward the valley sides. Montezuma Creek is in hydraulic communication with the aquifer on the upstream side of the East Tailings Pile. However, because of a realignment of the stream channel, the aquifer and Montezuma Creek are separated in the vicinity of the East Tailings Pile. The creek and the aquifer are reunited downstream of the tailings pile.

Sources of recharge to the alluvial aquifer are infiltration of precipitation and surface water and seepage from fractures in the Mancos Shale along the boundary of the alluvial aquifer. Discharge from the alluvial aquifer is estimated to be approximately 113,550 to 132,475 liters (30,000 to 35,000 gallons) per day across the East Tailings Pile. Water quality in the alluvial aquifer becomes degraded as it traverses the site by leachate migrating through the tailings. The leachate contributes uranium, vanadium, radium, sulfate, selenium, and molybdenum to ground water in the alluvial aquifer. The alluvial aquifer is not being used for any purpose in the area.

City of Monticello

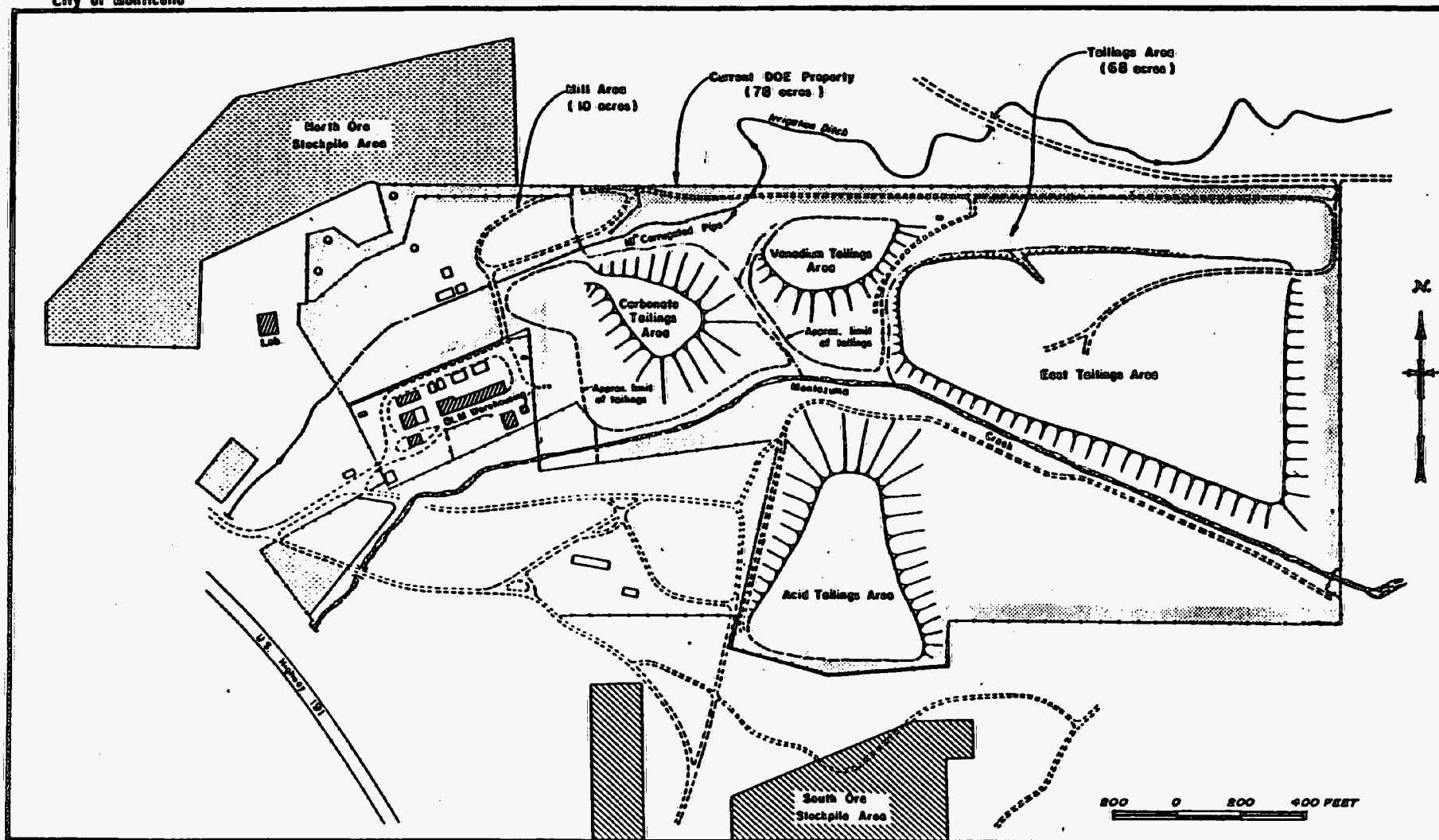


Figure 1. Monticello Millsite Plan

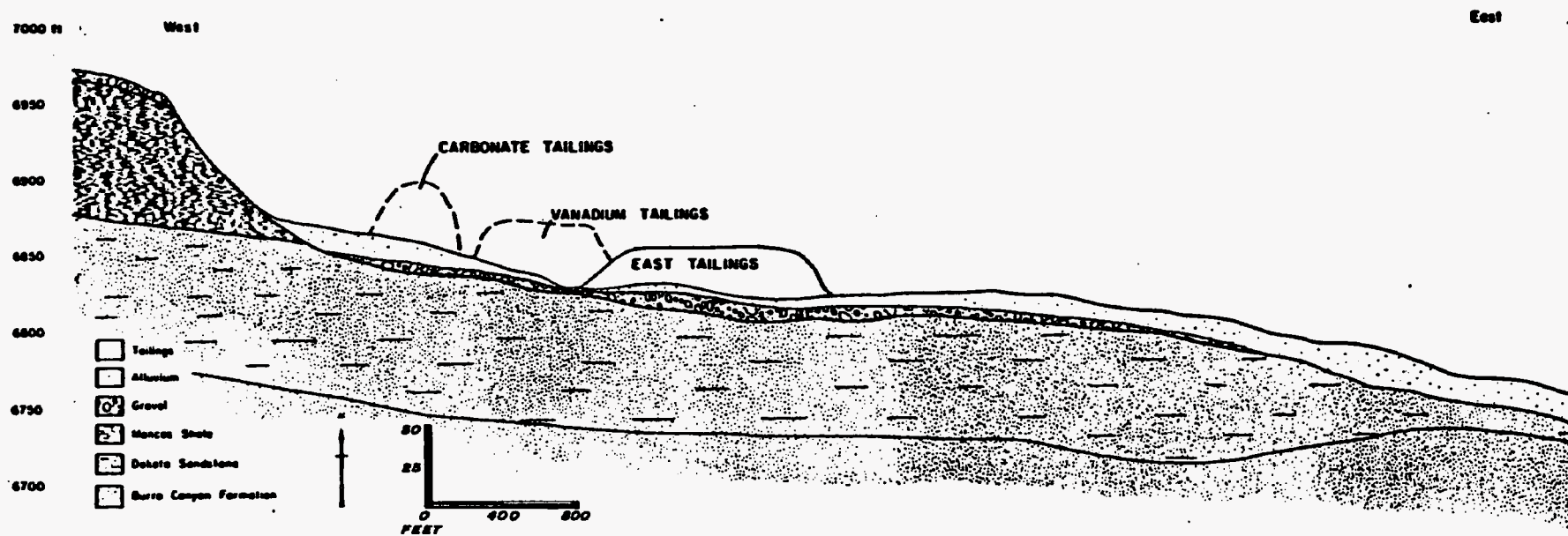


Figure 2. Generalized West-East Cross Section Through the Project Area (Dakota/Burro Canyon based on core data).

The Burro Canyon Formation is a confined aquifer which underlies the alluvial aquifer. It is separated from the alluvial aquifer by an aquitard consisting of the Mancos Shale and silty sandy units of the Dakota Sandstone. The Burro Canyon Formation is tilted and exposed along the margin of the Abajo dome; this is the recharge zone for the Burro Canyon aquifer. Discharge from the aquifer occurs across the Great Sage Plain, along erosional margins, and in areas where canyons dissect the formation. Numerous stock ponds and marshy areas are created as a result of spring-fed discharge from the Burro Canyon aquifer.

There is presently no evidence that the Burro Canyon aquifer is being degraded by the tailings piles. Water in the Burro Canyon aquifer is used occasionally for domestic water supply.

1987 Sampling and Results

Ground-water samples were collected at the Monticello site in May and October of 1987 using a peristaltic pump, a bladder pump, or a Teflon bailer. Eighteen samples were collected in May, twelve in October. Because the site had been extensively characterized previously, the number of samples was reduced for the 1987 calendar year. Samples requiring filtration were run through a 0.45- μ m filter in line with the collection vessel. The samples were then preserved as required and analyzed according to procedures prescribed in Korte and Ealey (1983), Korte and Kearl (1985), and Environmental Protection Agency (EPA) standards (U.S. Environmental Protection Agency, 1979a, 1979b, 1980, 1982a, 1982b). The samples were analyzed for those analytes listed in the Appendix. Samples were collected upgradient of the site, on site, and downgradient.

Shallow-aquifer background ground-water-quality data have been acquired from Wells 19, 20, 43, and 44, (see Figure 3, pg. 11). Over the past six years, elements not detected or found in very low concentrations include As, Ba, Cl, Fe, Mo, Pb, Se, V, Zn, and Ra-226. Elevated uranium and manganese concentrations have been observed at various times in past analyses. In 1987, only Wells 20 and 43 were sampled: the uranium concentration averaged only 0.015 mg/l in Well 43 and was below detection in Well 20; the manganese concentration was 0.078 mg/l in Well 43.

Ground water in the shallow aquifer is contaminated by elements leached from the tailings piles (Tables 1 and 2). In general, the highest concentrations of contaminants are found in the vicinity of the Carbonate and Vanadium Piles. High uranium content is found in Well 36A on the east side of the East Tailings Pile and in off-site Well 1 on the private property immediately east of the Government property (Table 2).

The shallow-aquifer monitoring wells on the private property east of the Government property are contaminated with uranium, molybdenum, vanadium, and selenium. The data presented in previous Environmental Monitoring Reports indicate that concentrations of these elements remain high throughout the year. The aquifer is the major water source for the creek during the dry months and often results in relatively high levels of contamination in the creek during those periods. Wells 9 and 13 are located as far east of the Government property as 1 kilometer (0.6 mile) but are still significantly contaminated.

Table 1. Contamination in Shallow On-Site Monitoring Wells

Well	Contaminant Concentration ^a										
	As	Cl	Fe	Mn	Mo	NO ₃	Ra-226	Se	SO ₄	U	V
30B	0.16	82.6	0.14	3.2	0.33	<1.0	-	0.08	554	0.65	3.96
36A	0.006	90.9	<0.1	12.3	1.24	123.0	18.6	<0.005	3580	11.7	<0.05
40A	0.06	74.2	0.25	3.08	0.29	<1.0	4.0	0.006	516	1.19	0.54
45B	<0.05	13.0	0.12	0.154	<0.05	12.05	-	<0.005	222	0.025	<0.05

^aAll results are in mg/l except those for Ra-226 which are in pCi/l. Results represent averages where two samplings were made in 1987.

Table 2. Contamination in Shallow Off-Site Monitoring Wells

Well	Contaminant Concentration ^a								
	As	Fe	Mn	Mo	NO ₃	Ra-226	Se	U	V
1	3.4	<0.10	4.25	0.39	3.4	<0.2	0.012	2.02	1.13
7	0.005	<0.10	0.026	0.05	9.1	-	0.012	0.325	0.06
8	<0.005	<0.10	<0.025	<0.05	1.3	-	0.008	0.195	<0.05
9	<0.005	<0.10	0.283	0.11	<0.5	-	<0.005	0.555	<0.05
13	<0.005	0.17	0.079	<0.05	<0.5	-	<0.005	0.414	<0.05

^aAll results are in mg/l except those for Ra-226 which are in pCi/l. Results represent averages where two samplings were made in 1987.

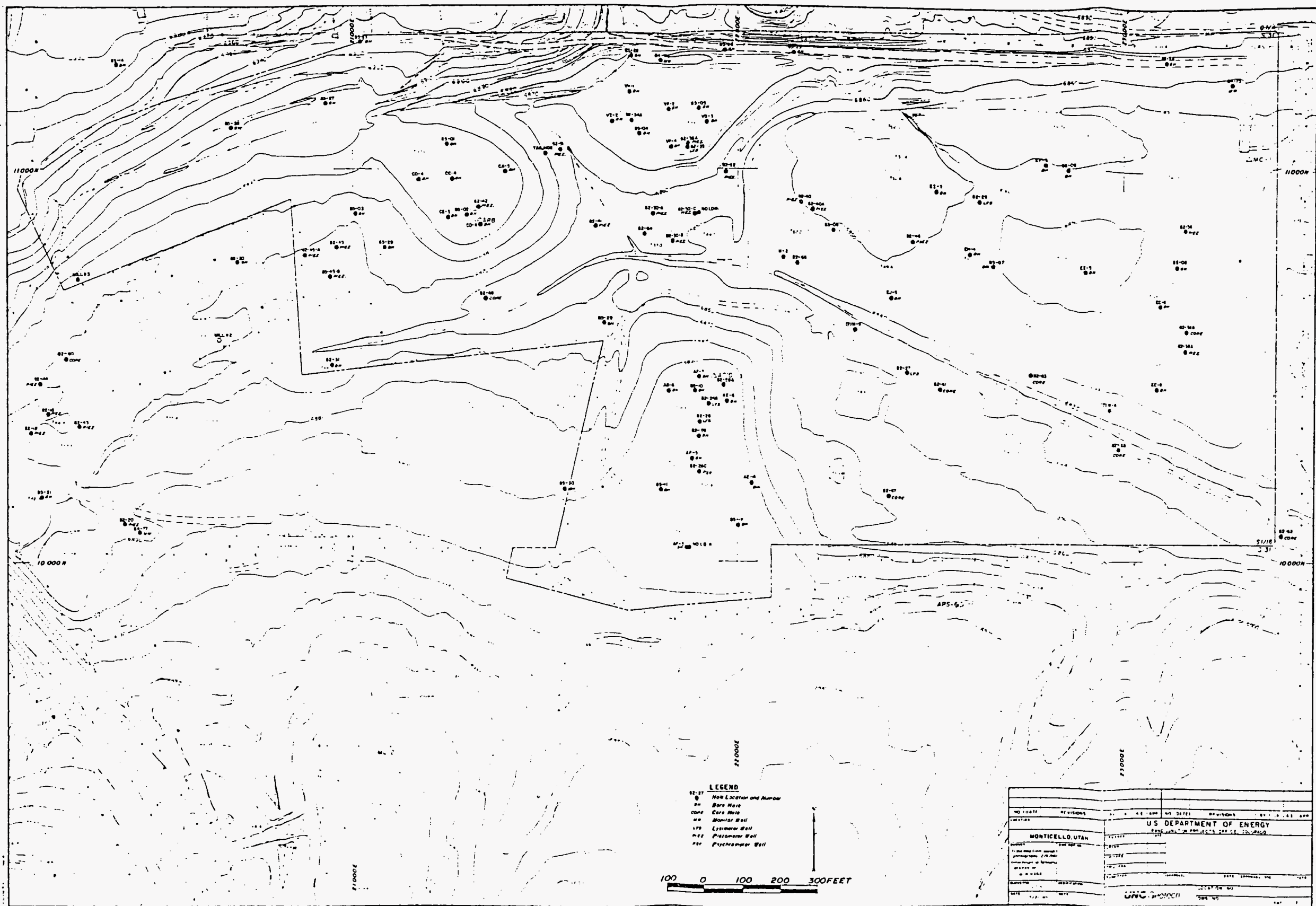


Figure 3. Locations of Ground-Water Monitoring Wells at the Monticello Millsite.

Comparison to Standards

To facilitate the comparison of alluvial aquifer ground-water data to the applicable or relevant and appropriate requirements (ARARs), maximum concentrations were identified from data collected during 1984 to 1987 (UNC Geotech, 1988a). Subsequently, these maximum concentrations were compared to the standards. The ARARs considered for comparison are the Uranium Mill Tailings Radiation Control Act of 1978 Ground-Water Standards and the EPA and State of Utah Drinking Water Quality Standards. The comparisons are presented in Tables 3 and 4. Parameters that exceed their standards are readily identifiable in the tables and include Ra-226, gross alpha, arsenic, selenium, and nitrate. If the proposed new groundwater standards for UMTRCA are adopted, molybdenum and uranium will also exceed standards.

SURFACE WATER

Surface-water monitoring at the Monticello site has provided extensive baseline data over the past seven years. The 1987 monitoring activities were significantly reduced from those of previous years, the primary goal being to detect only major changes in water chemistry. Consequently, only one set of samples was collected from two locations in Montezuma Creek during the May 1987 sampling. The results did not indicate a change over previous years (see Appendix).

Montezuma Creek is the main surface water body in the project area. Solute concentrations in the creek increase downstream of the site because of the mixing of the creek with alluvial-aquifer discharge. Surface water is used as a source of municipal water supply beginning about 1.6 kilometers (1 mile) upstream of the tailings area. Downstream of the tailings area, surface water is used primarily for stock watering.

Background surface-water quality is monitored at site W-3, shown in Figure 4. This sampling point is located east of the culvert under U.S. Highway 191. In past years, upstream samples (site I-1) have also been collected to verify that the W-3 site accurately represents the background water quality of Montezuma Creek (Korte and Thul, 1982, 1983).

1987 Sampling and Results

In the May 1987 sampling, surface water at site W-3 was characterized by low levels of mill-tailings-related contaminants, a pH of 7.6, a specific conductance of 220 μ mhos/cm, and an alkalinity of 110 mg/l (as CaCO_3). Previous years of monitoring have shown that elements not detected or found in very low concentrations include As, Ba, Cr, Fe, Mn, Mo, Pb, Se, U, V, and Zn; no Ra-226 has been detected (see Appendix).

Permanent surface water on the Government property consists of perennial flow in Montezuma Creek and in the drainage between the Carbonate and Vanadium Piles (drainage designated W-2 on the map in Figure 4). There is intermittent water in seeps south of the Carbonate and Vanadium Piles and east of the Acid Pile. The Vanadium and Acid Pile seeps contain water in the spring due to the melting of snow. The seep adjacent to the Vanadium Pile generally covers an

Table 3. Comparison of Maximum Concentration^a of Selected Constituents in Alluvial Aquifer at Monticello Millsite with Uranium Mill Tailings Radiation Control Act of 1978 Ground-Water Standards^b

Constituent	UMTRCA Concentration Maximum	Monticello Millsite and Peripheral Properties Maximum Concentration		
		Upgradient	On Site	Downgradient
Arsenic	0.05	0.01	0.19	0.02
Barium	1.0	<0.10	0.85	<0.10
Cadmium	0.01	<0.005	0.005	<0.001
Chromium	0.05	0.01	0.02	<0.01
Lead	0.05	<0.025	<0.025*	<0.01
Mercury	0.002	0.002	<0.0002*	<0.0002
Molybdenum ^c	--	0.13	1.44	0.213
Selenium	0.01	0.013	0.16	0.018
Silver	0.05	<0.025	<0.025*	<0.010
Uranium ^c	--	0.006	12.8	0.80
Endrin (1,2,3,4,10, 10-hexachloro-1, 7-epoxy-1,4,4a,5,6, 7,8,9a-octahydro-1, 4-endo, endo-5.8- dimethano naphthalene)	0.0002		<0.012*	
Lindane (1,2,3,4,5, 6-hexachlorocyclohexane, gamma isomer)	0.004		<0.008*	
Methoxychlor (1,1,1, -Trichloro-2,2-bis (p-methoxyphenylethane)	0.1		<0.005*	
Toxaphene (C ₁₀ H ₁₀ Cl ₄ Technical chlorinated camphene, 67-69 percent chlorine)	0.0005		<0.48*	
2,4-D (2,4 Dichloro- phenoxyacetic acid)	0.1		<0.2*	
2,4,5-TP Silvex (2,4,5- Trichlorophenoxypropionic acid)	0.01	NS ^d	NS	NS
Combined radium-226 and radium-228	5	0.20	38.0	<2.0
Gross alpha-particle activity (excluding radon and uranium)	15	15	7280.0	134

^aAll results are in mg/l except for radium and gross alpha, which are in pCi/l. A "<" symbol indicates the maximum concentration was below detection limits (number shown is detection limit). An asterisk (*) indicates that the value applies to all samples. (Based on data collected from 1984-1987.)

^b40 CFR 192; revised 7/1/86.

^cNo concentration limits have yet been finalized for molybdenum and uranium. Currently EPA is proposing to delist molybdenum from the Safe Drinking Water Act.

^dNS = Not sampled

Table 4. Comparison of Maximum Concentration^a of Constituents in Alluvial Aquifer at Monticello Millsite with EPA and State of Utah Drinking Water Quality Standards

Constituent	Standards			Maximum Concentration			EXCEEDS? Yes/No
	EPA Primary	EPA Secondary	Utah	Up- gradient	On-Site	Down- gradient	
Arsenic	0.0	--	0.05	0.01	0.19	0.02	Yes
Barium	1.00	--	1.00	<0.10	0.85	<0.10	No
Cadmium	0.01	--	0.01	<0.005	0.005	<0.001	No
Chloride	--	250.00	250.00	17.9	150	1080	Yes
Chromium	0.05	--	0.05	0.01	0.02	<0.01	No
Fluoride	4.00	--	1.6-2.1	0.20	1.2	0.73	No
Iron	--	0.30	0.30	0.60	3	0.81	Yes
Lead	0.05	--	--	<0.025	0.025*	<0.01	No
Manganese	--	0.05	0.05	2.0	21	1.22	Yes
Mercury	0.002	--	0.002	0.002	<0.0002*	<0.0002	No
Nitrate	10.00	--	10.00	18.3	160	4.0	Yes
pH (S.U.)	--	6.5 to 8.5	6.5-8.5	7.5	7.4	7.6	No
Selenium	0.01	--	--	0.013	0.16	0.018	Yes
Silver	0.05	--	0.05	<0.025	<0.025	<0.010	No
Sulfate	250.00	250.00	250.00	682	3900	1200	Yes
Zinc	--	5.00	5.00	2.82	1.40	0.47	No
Ra-226 (pCi/l)	5	--	5	0.20	38	<2.0	Yes
Gross alpha ^b (pCi/l)	15	--	15	15	7280	134	Yes
Organic Constituents							
(µg/l)							
Endrin	0.2	--	0.2			<0.012*	No
Lindane	4.0	--	4.0			<0.008*	No
Methoxychlor	100.0	--	100.0			<0.005*	No
Toxaphene	5.0	--	--			<0.48*	No
2, 4-D	100.0	--	100.0				--
2,4,5-TP	10.0	--	10.0				--
Phenols	1.0	--	--			<0.01	No

^aAll values in table are given in mg/l except as specifically designated otherwise. Maximum concentrations reported for millsite area are based on 1984-1987 monitoring results. A "<" symbol indicates the maximum concentration was below detection limits (number shown is detection limit); those values followed by an asterisk (*) signify that all samples yielded the stated value.

^bGross alpha includes Ra-226 but not radon and uranium activity.

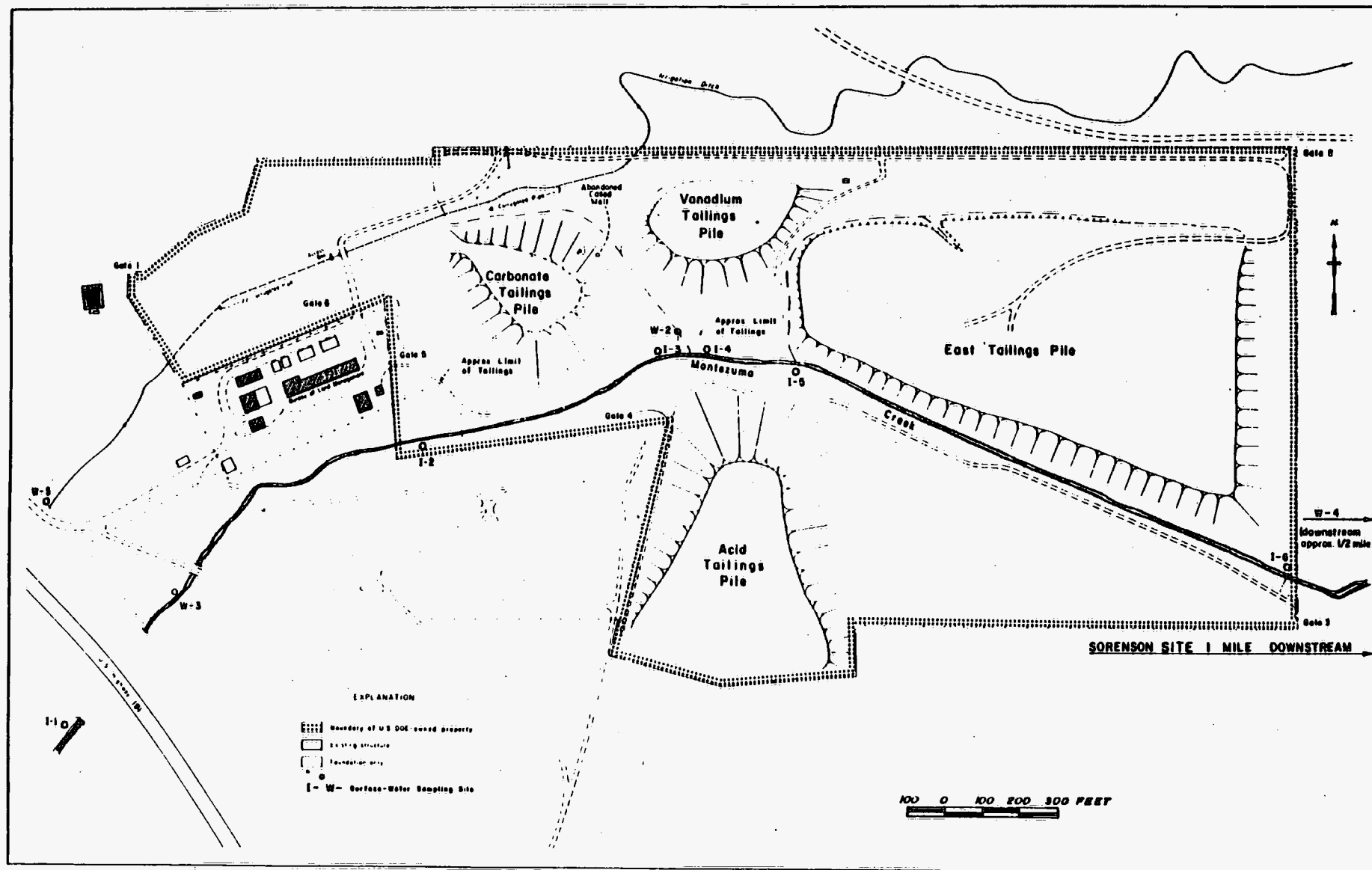


Figure 4. Locations of Surface-Water Sampling Sites at the Monticello Millsite.

area as large as 4.5 square meters (5 square yards) to a depth of 15 to 30 centimeters (8 to 15 inches). The Acid Pile seep is contained by a small dam and, when full, is approximately four times larger in area than the Vanadium Pile seep.

The seep adjacent to the Carbonate Pile forms a small pond covering approximately 12.5 square meters (15 square yards). This pond contains water throughout the summer and supports a few cattails; typically, it is the only one of the three seeps that contains water during the dry seasons.

A diversion ditch was constructed north of the East Tailings Pile in 1984 in an attempt to divert some water away from the piles and thereby decrease the volume of contaminated water that seeps out of the piles. Visual observations during 1985, however, did not indicate any decrease in water in the various seeps and small drainages that surround the piles.

Montezuma Creek flows through the middle of the property. As mentioned earlier, flow is perennial, although it can be quite low during the late summer. There can also be substantial flooding, as occurred in the spring of 1983. Results of previous studies (Korte and Thul, 1982, 1983) indicate that uranium contamination of the creek occurs prior to the point at which the creek traverses the tailings piles. However, concentrations of both molybdenum and uranium are typically higher downgradient and off site, which demonstrates that contributions from the alluvial aquifer to Montezuma Creek occur to the greatest extent downstream of the Government property. The 1987 surface-water sampling was conducted only on Montezuma Creek. The past years of sampling have documented well the contamination in the various seeps adjacent to the tailings piles.

Seeps from the shallow aquifer are visible along the creek below the drop structure. Creek flow increases for approximately 2 kilometers (1.25 miles) and is perennial along this stretch. The W-4 sampling site is located approximately 100 meters (325 feet) downstream of the east boundary of the property. Except under conditions of very high flow, as during a storm event or spring runoff, contamination levels frequently exceed State of Utah standards.

Samples have routinely been collected at what is known as the Sorenson site, located approximately 2 kilometers (1.25 miles) downstream of the Government property. Data comparison has shown little decrease in contamination between the W-4 site and the Sorenson site. The shallow aquifer is contaminated as far downgradient as it has been sampled, and thus maintains high concentrations of the contaminants in Montezuma Creek for a considerable distance off site. The downstream water quality of Montezuma Creek is described in detail in the 1983 Environmental Monitoring Report (Korte and Thul, 1984) and in the Draft RI (UNC Geotech, 1988a).

Comparison to Standards

A comparison of data from surface-water samples collected from 1984-1987 to State of Utah Surface Water Standards is presented in Table 5. As previously discussed, concentrations of arsenic, gross alpha, Ra-226, nitrate, selenium, silver, sulfate, and zinc in Montezuma Creek have exceeded State standards.

Table 5. Comparison of Maximum Concentration^a of Selected Constituents in Montezuma Creek with State of Utah Surface Water Standards

Constituent	Utah Standard	Montezuma Creek Maximum Concentrations ^b			Standard Exceeded? (Yes/No)
		Upgradient	On-Site	Downgradient	
Arsenic	0.05	<0.01 ^c	3.5	0.027	Yes
Barium	1.0	<0.10	0.85	0.12	No
Cadmium*	0.010	<0.001	<0.001	<0.001	No
Chromium*	0.05	<0.005	<0.005	<0.005	No
Fluoride*	1.4-2.4	<1.0	<1.0	<1.0	No
Gross Alpha (pCi/l above background)	15	17	991	262	Yes
Iron	1.0	0.10	0.30	0.15	No
Lead*	0.01	0.003	0.003	0.001	No
Mercury*	0.002	<0.002	<0.002	<0.002	No
Nitrate	1.0	3.0	390.0	10.0	Yes
Radium 226 (pCi/l)	5		23.8		Yes
Radium 228 (pCi/l)	5	<1.0	<1.0	<1.0	No
Selenium	0.05	<0.01	3.11	0.04	Yes
Silver*	0.01	<0.0005	0.016	0.002	Yes
Sulfate	1000	190	4200.0	786	Yes
Zinc	0.05	1.02	0.33	1.46	Yes
pH (S.U.)	6.5-9.0	8.6	10	8.6	Yes

^aData are from 1984-1987 samplings except those for constituents labeled with an asterisk (*), which are from samplings prior to 1984.

^bAll values are in milligrams per liter (mg/l) except where designated otherwise.

^cA "<" symbol indicates the maximum concentration was below detection limits (number shown is detection limit).

AIR QUALITY

Atmospheric Radon

Environmental radon measurements were taken at the Monticello site in 1984. The measurements were taken on the pile, at the site boundary, and at off-site locations using Terradex Track Etch® detectors exposed in duplicate, located 0.9 meter (3 feet) above ground level. Atmospheric radon continues to be monitored with Track Etch® detectors, although the number of sample locations has been reduced from 19 to 8 since the conclusion of the 1984 sampling period (Figure 5). The 1987 annual average radon concentrations measured during 1987 are listed in Table 6 (pg. 21). During this more recent measurement period, the annual average radon standard specified by 40 CFR 192 was exceeded at ST-4, ST-6, and ST-7. These values are consistent with the previous years' annual averages, which indicates a constant rate of radon emission from the piles. The radon emission described in the following section, although measured in a previous year, can be considered representative of the 1987 monitoring period.

Radon Emission

Extensive measurements of radon flux from the tailings piles were taken during 1984; results of these measurements are presented in detail in the Draft EA (UNC Geotech, 1988b). The data demonstrate that the EPA standard of $20 \text{ pCi} \cdot \text{m}^{-2} \cdot \text{sec}^{-1}$ for radon emission from inactive uranium processing sites is exceeded at all four tailings piles at the Monticello site.

The radon source strength, area, and weighted average radon flux for each tailings pile are presented in Table 7.

Table 7. Radon Source Strength, Area, and Weighted Average Radon Flux for the Monticello Tailings Piles

Tailings Pile	Radon Source Strength (Ci/Yr)	Area (m ²)	Weighted-Average Radon Flux (pCi·m ⁻² ·sec ⁻¹)
Acid Pile	512.7	52,070	312
Carbonate Pile	571.1	23,657	765
Vanadium Pile	88.5	16,216	173
East Pile	<u>401.9</u>	95,746	133
Total	1574.2		

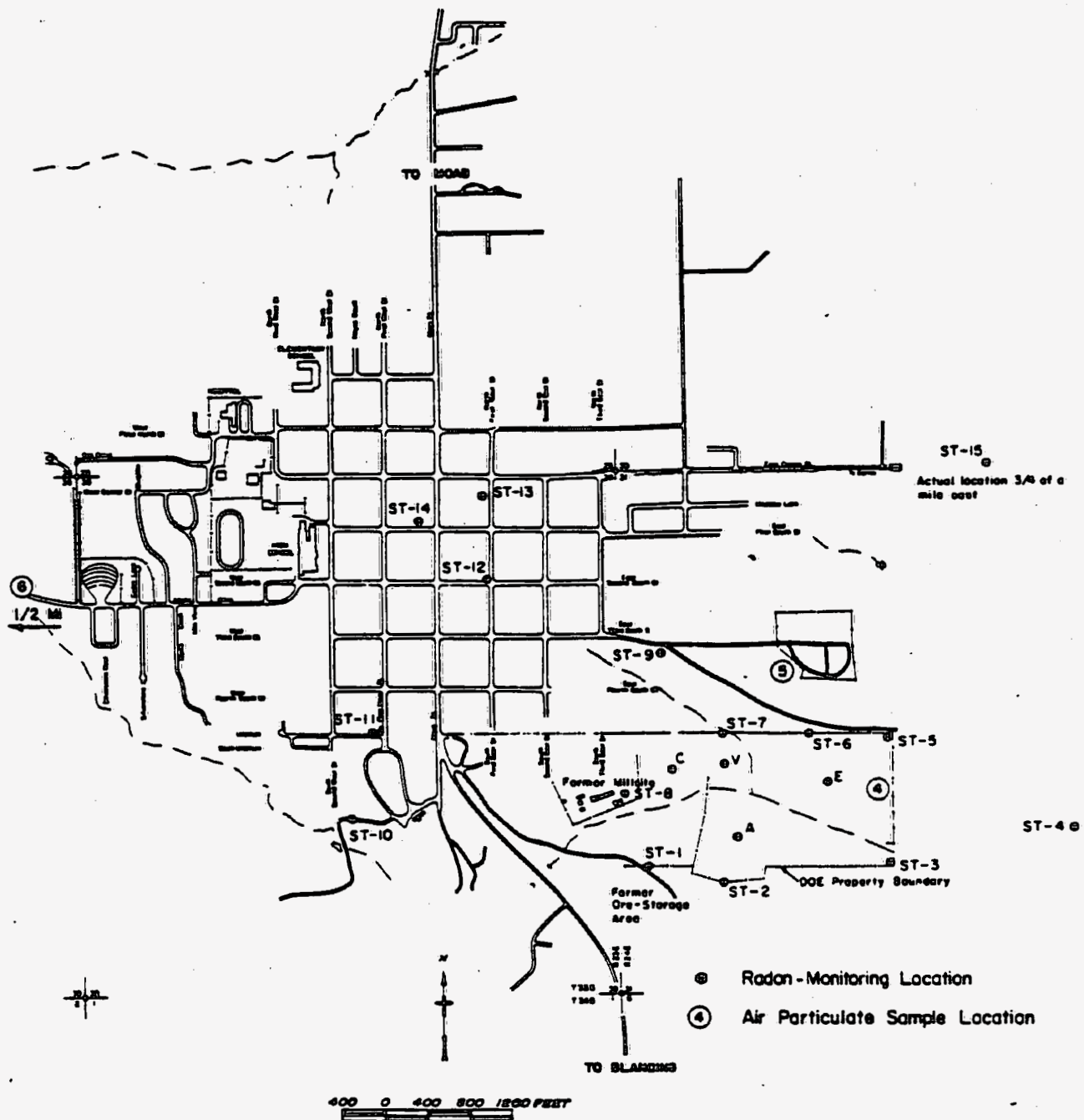


Figure 5. Sampling Locations for Radon and Air Particulate Monitoring in the Monticello Study Area.

Table 6. Summary of Radon Concentrations for the Monticello Area
for the Period of 14 November 1986 through 20 November 1987

Sampling Location	Radon Concentration (pCi/l) ^a				
	Annual Average	First Quarter ^b	Second Quarter ^c	Third Quarter ^d	Fourth Quarter ^e
ST-4	1.1 ± .03	0.8 ± .05	0.6 ± .04	1.4 ± .07	1.7 ± .08
ST-6	1.0 ± .03	0.6 ± .04	0.5 ± .04	1.3 ± .07	1.7 ± .08
ST-7	1.7 ± .04	1.2 ± .06	1.5 ± .07	2.2 ± .09	1.9 ± .08
ST-10	0.4 ± .02	0.3 ± .03	0.3 ± .03	0.5 ± .04	0.6 ± .05
ST-11	0.4 ± .02	0.3 ± .03	0.3 ± .03	0.4 ± .03	0.6 ± .05
ST-13	0.4 ± .02	0.3 ± .03	0.4 ± .03	0.4 ± .03	0.7 ± .05
ST-14	0.3 ± .02	0.2 ± .02	0.2 ± .02	0.4 ± .03	0.6 ± .05
ST-15	0.3 ± .02	0.2 ± .02	0.3 ± .03	0.5 ± .04	0.6 ± .04

^aUncertainties are 1 standard deviation, based on Poisson counting statistics. The units are reported as pCi/l to be consistent with the EPA standard 40 CFR part 192. To convert pCi/l to µCi/ml, multiply by 1×10^{-9} .

^bNovember 14, 1986 through February 19, 1987.

^cFebruary 19, 1987 through May 28, 1987.

^dMay 28, 1987 through August 7, 1987.

^eAugust 7, 1987 through November 20, 1987.

Air Particulates

Inhalable particulate samplers based on the design by Wedding (1982) were installed at the Monticello site. The samplers are Sierra-Anderson Series 300 and are equipped with constant-flow controllers, mechanical timers, and Series-320-size selective inlets. Flow-rate calibration is accomplished with a Kurz Model 341 electronic mass flow meter.

Samplers are operated at 1133 liters per minute (lpm) (40 cubic feet per minute) for 24 hours, running midnight-to-midnight every sixth day. Sample-collection media are Whatman Number 41 cellulose filters.

Wind-rose data collected on site have clearly identified two principal wind vectors in the area, one to the east and one to the north. Thus, sampling stations were located along these two directions as well as at a background site (Figure 5).

The background site is located approximately 0.5 kilometer (0.3 mile) west of the city of Monticello near the pumphouse building for the city water supply. The intake port for this sampler is 3 meters (10 feet) above ground level. The area west of this site is mostly natural desert and mountainous terrain. There are no nearby industrial activities.

The east site is located on the eastern edge of the East Tailings Pile. The sampler was placed on a steel tower such that the intake was mounted approximately 3 meters (10 feet) above ground level.

The north site is located on the west side of the City of Monticello cemetery grounds. This location is 30 meters (100 feet) north of the tailings area at an elevation 100 meters (330 feet) above the piles. The sampler intake is 4 meters (13 feet) above ground level.

Air-particulate sampling for 1987 was initiated in April. (Sampling was suspended during the period November 1986 to April 1987 because of inclement weather.) A total of 83 samples were collected in 1987. Table 8 lists, for all selected elements, maximum concentrations and mean concentrations above detection limits (ADL) measured during the 1987 sampling program.

Comparison to Standards

The EPA standard (40 CFR Part 192) for atmospheric radon concentration at the edge of an inactive uranium mill tailings pile is 0.50 pCi/l above background. If 0.41 pCi/l is used as the average annual background for Monticello (UNC Geotech, 1988a), the site-specific EPA standard is calculated to be 0.91 pCi/l. Examination of the data in Table 6 reveals that the EPA standard is exceeded at both edge-of-pile locations (ST-6 and ST-7). The only off-site location exceeding the standard is ST-4.

Radiologic air particulate levels are regulated at the Monticello site by DOE Order 5480.1; the standards applicable to Monticello are given as concentrations above natural background. The reported limits for an uncontrolled area, averaged over one year, are 3×10^{-12} $\mu\text{Ci/ml}$ radium-226, 8×10^{-14} $\mu\text{Ci/ml}$ thorium-230, and 3×10^{-12} $\mu\text{Ci/ml}$ natural uranium. Examination of the data in

Table 8. Results of Monticello Air Particulate Study Conducted During 1987

Element	Maximum Concentration			Annual Average Concentration ^a			Number of Samples ^b		
	Station	Station	Station	Station	Station	Station	Station	Station	Station
	4 East	5 North	6 B.G.	4 East	5 North	6 B.G.	4 East	5 North	6 B.G.
<u>RADIOACTIVE ELEMENTS</u>									
Uranium (µg/m ³)	0.006			0.0006			26(1)	29(0)	28(0)
(µCi/ml)	2.0 x 10 ⁻¹⁰			2.0 x 10 ⁻¹⁰					
Radium-226 (µCi/ml)	5.0 x 10 ⁻¹⁰	6.0 x 10 ⁻¹⁰	3.4 x 10 ⁻¹⁰	3.0 x 10 ⁻¹⁰	3.0 x 10 ⁻¹⁰	9.0 x 10 ⁻¹⁰	26(6)	29(8)	28(6)
Thorium-230 (µCi/ml)	1.3 x 10 ⁻¹⁰	2.0 x 10 ⁻¹⁰	1.3 x 10 ⁻¹⁰	4.0 x 10 ⁻¹⁰	2.0 x 10 ⁻¹⁰	3.0 x 10 ⁻¹⁰	26(8)	29(7)	28(7)
<u>NONRADIOLOGIC ELEMENT</u>									
Lead (µg/m ³)	0.0858	0.0129	0.0129	0.0200	0.0072	0.0063	26(6)	29(4)	28(3)

^aAverage is calculated using only those values above the minimum detection limit.

^bNumber in parentheses indicates number of samples above detection limit.

Table 8 shows the highest annual average concentrations of the subject elements (inclusive of background levels) to be 9×10^{-10} $\mu\text{Ci/ml}$ radium-226, 4×10^{-10} $\mu\text{Ci/ml}$ thorium-230, and 2×10^{-10} $\mu\text{Ci/ml}$ natural uranium, values that are clearly below the standard.

Lead is the only nonradioactive airborne particulate measured at the Monticello Facility that is regulated by a specific standard. Acceptable levels of this element are defined by the EPA under the National Ambient Air Quality Standards (NAAQS). The standard specifies that a 3-month average concentration of lead is not to exceed $1.5 \mu\text{g/m}^3$. The maximum concentration measured at the site is $0.0858 \mu\text{g/m}^3$ (see Table 8), a level clearly below the compliance standard.

ENVIRONMENTAL COMPLIANCE ACTIVITIES

The Monticello Millsite is non-operational and as a result does not have operational environmental requirements. However, two items related to planned remediation activities at the Monticello Millsite that necessitate regulatory involvement are: 1) submittal of the Hazard Ranking System (HRS) Score for the Monticello Millsite and 2) the DOE/EPA Interagency Agreement for the Monticello Remedial Activities.

ENVIRONMENTAL MONITORING REPORT

An Environmental Monitoring Report for calendar year 1986 was submitted in 1987 for the Monticello site.

SUBMITTAL OF HAZARD RANKING SYSTEM (HRS) SCORE

The Monticello Millsite was scored using the Hazard Ranking System (HRS) for possible inclusion on the Superfund National Priority List (NPL). A score of 28.5 is required for inclusion. The internal evaluation resulted in a score of 52.0 for the millsite, a score which was submitted to the EPA Region VIII on 31 October 1987. The submittal will undergo evaluation by the EPA for accuracy and completeness. Results of EPA's review and determination are expected in 1988.

INTERAGENCY AGREEMENT FOR THE MONTICELLO REMEDIAL ACTIVITIES

Ongoing negotiations between the DOE and EPA Region VIII resulted in pursuing several courses during 1987 without success. Initial attempts to reach agreement via a Memorandum of Understanding were terminated in September 1987 when the EPA Region VIII issued an Administrative Order of Consent under CERCLA Section 106e for the Monticello Vicinity Properties (MVPs). However, additional negotiations between the DOE and EPA resulted in combining the MVPs and Monticello Millsite into one overall agreement. This process was to be undertaken in the form of an Interagency Agreement under CERCLA Section 120. Continued negotiations between all parties, the DOE, EPA, and the State of Utah, will continue in 1988.

SUMMARY OF POTENTIAL HEALTH EFFECTS

A quantitative assessment of the potential health effects associated with tailings-related contamination is presented in the Draft RI/FS (UNC Geotech, 1988a). The assessment is based mostly on site-specific data collected from 1981 through 1986. The monitoring data collected in 1987, although more limited in scope, indicate that the ground water and atmospheric radon concentrations are relatively consistent with previous years' values. In view of this, and because there were no operational activities at the site in 1987 that would be expected to cause a significant increase in the source terms, a risk assessment based on the 1987 monitoring data was not undertaken. The following risk estimates, summarized from the Draft RI/FS, are therefore considered to be representative of the site during 1987.

The population doses to the approximately 2469 Monticello residents from natural background radiation and from the tailings piles in their present condition are listed in Table 9. The data demonstrate that the major contributor to the overall risk to Monticello residents from the tailings piles is natural background radiation.

Table 9. Population Dose Commitments to Monticello Residents from Natural Background and the Present Enhanced Conditions

Source	Dose Commitment (man-rem per year)	
	Whole Body	Lung
<u>NATURAL BACKGROUND</u>		
Direct External Exposure	316	
Radon Daughters		1265
<u>ENHANCED CONDITIONS</u>		
Direct External Exposure	0	
Radon Daughters		188

Population dose commitments and potential toxic effects of nonradiologic contaminants associated with the Monticello site are discussed in the Draft RI/FS (UNC Geotech, 1988a). Although contaminant levels are low, there remains some potential for adverse health effects resulting from chance exposure to nonradiologic contaminants found in Montezuma Creek and soils on the floodplain. However, there have been no incidents reported. The potential for toxicity was derived from a comparison of contaminant levels with acceptable intakes for chronic exposure (AICs).

When average soil concentrations were used, none of the dose levels was exceeded, which indicates that there is no apparent need for concern. When maximum soil concentrations were used, copper, uranium, and zinc exceeded the recommended limits for children. However, because of the low population densities along the Montezuma Creek drainage and the land use patterns in the

area, it is unlikely that individuals would receive chronic exposures to these maximum concentrations.

Several elements found in Montezuma Creek regularly exceed State and Federal water quality standards: selenium, zinc, manganese, arsenic, and molybdenum. The potential for exposure to these elements dictates that this water should not be used for drinking by humans or cattle. Use of this water to irrigate the alfalfa on which cattle graze appears to be acceptable because average exposure doses do not exceed AICs. However, it is recommended that vegetables not be grown in the Montezuma floodplain.

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APPENDIX

1987 Water Chemistry Data for the Monticello Millsite

1987 Water Chemistry Data for Monticello Millsite^a

Location	Date	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO ₄ (mg/l) as CaCO ₃	Ally (mg/l)	NO ₃ (mg/l)	Fe (mg/l)	Mn (mg/l)	As (mg/l)	Se (mg/l)	Mo (mg/l)	V (mg/l)	U (mg/l)	²²⁶ Ra (pCi/l)	²²⁸ Ra (pCi/l)	ALPHA (pCi/l)	pH	Eh ^{bc} (mv)	DO (mg/l)	T _{emp} (°C)
02-0	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	365.0	2.0	No Data	No Data	<0.005	<0.005	<0.050	<0.050	0.114	0.200	<1.000	34.200	6.40	No Data	2790	12.0
02-20	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	325.0	174.0	No Data	No Data	<0.005	0.022	<0.050	<0.050	0.010	<0.100	<1.000	27.600	7.00	No Data	1700	9.5
02-30B	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	440.0	<1.0	No Data	No Data	0.174	0.119	0.410	4.220	0.612	0.300	<1.000	454.000	7.00	No Data	2100	10.0
02-31B-E	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	355.0	6.5	No Data	No Data	<0.005	<0.005	<0.050	<0.050	0.024	0.200	<1.000	30.200	6.95	No Data	2820	12.5
02-36A	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	720.0	117.0	No Data	No Data	<0.005	<0.005	1.230	<0.050	10.900	10.000	<1.000	5892.000	6.90	No Data	9410	10.0
02-40A	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	432.0	<1.0	No Data	No Data	0.065	0.006	0.300	0.530	1.330	4.000	<1.000	905.000	6.85	No Data	2170	10.0
02-43	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	279.0	136.0	No Data	No Data	<0.005	0.010	<0.050	<0.050	0.020	<0.100	<1.000	9.700	6.80	No Data	2440	9.5
02-45B	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	293.0	20.7	No Data	No Data	<0.005	<0.005	<0.050	<0.050	0.026	0.500	<1.000	24.000	6.75	No Data	1300	11.0
02-51	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	373.0	<1.0	No Data	No Data	0.005	<0.005	<0.050	<0.050	0.047	0.300	<1.000	22.000	6.90	No Data	1350	9.5
02-52	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	381.0	<1.0	No Data	No Data	0.016	<0.005	<0.050	<0.050	0.073	<0.100	<1.000	48.000	6.80	No Data	1470	10.0
03-74	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	219.0	<1.0	No Data	No Data	<0.005	<0.005	<0.050	<0.050	<0.001	1.000	<1.000	13.100	7.40	No Data	564	10.5
02-45B	1987/10/13	No Data	No Data	No Data	No Data	No Data	No Data	293.0	20.5	No Data	No Data	<0.005	<0.005	<0.050	<0.050	0.029	0.500	<1.000	26.000	6.75	No Data	1300	11.0
W-3	1987/05/10	7.0	0.60	30.1	4.9	1.6	31.5	110.0	0.6	<0.100	<0.025	<0.005	<0.005	<0.050	<0.050	<0.001	No Data	No Data	No Data	7.60	200.0	220	6.0
02-43	1987/05/10	34.0	2.00	196.0	25.0	11.1	349.0	295.0	2.5	<0.100	0.078	<0.005	<0.005	<0.050	<0.050	0.011	No Data	No Data	No Data	6.90	140.0	1006	9.0
02-31B-E	1987/05/10	90.0	3.60	417.0	67.9	33.4	1010.0	612.0	22.0	<0.100	<0.025	<0.005	0.006	<0.050	<0.050	0.019	No Data	No Data	No Data	7.05	70.0	2075	10.5
02-7	1987/05/10	90.0	7.60	139.0	32.5	20.6	201.0	334.0	9.1	<0.100	0.026	0.005	0.012	0.050	0.060	0.325	No Data	No Data	No Data	7.00	170.0	1200	11.5
MONTICELLO CREEK @ E. BOUNDARY	1987/05/10	9.0	0.70	47.2	5.9	3.1	46.5	121.0	<0.5	<0.100	<0.025	<0.005	<0.005	<0.050	<0.050	0.004	No Data	No Data	No Data	7.70	140.0	275	14.5
02-13	1987/05/10	100.0	3.30	150.0	36.6	47.5	433.0	366.0	<0.5	0.170	0.079	<0.005	<0.005	<0.050	<0.050	0.414	No Data	No Data	No Data	6.90	70.0	1415	11.5
02-9	1987/05/10	120.0	12.50	167.0	36.3	40.9	433.0	322.0	<0.5	<0.100	0.283	<0.005	<0.005	0.110	<0.050	0.555	No Data	No Data	No Data	7.10	110.0	1331	10.0
02-0	1987/05/10	220.0	9.40	460.0	113.0	234.0	1360.0	440.0	0.6	<0.100	<0.025	<0.005	0.000	<0.050	<0.050	0.275	No Data	No Data	No Data	6.70	145.0	2067	11.0
02-1 LOWER	1987/05/10	400.0	31.90	175.0	43.1	97.9	880.0	502.0	3.4	<0.100	4.250	0.035	0.012	0.300	1.130	2.020	No Data	No Data	No Data	0.80	170.0	2594	12.0
02-45 LOWER	1987/05/10	75.0	6.60	176.0	29.3	21.2	340.0	380.0	<0.5	4.600	5.150	0.005	<0.005	<0.050	<0.050	0.083	No Data	No Data	No Data	6.80	<70.0	1160	11.0
02-40A	1987/05/10	270.0	41.60	126.0	26.3	74.2	516.0	420.0	<0.5	0.250	3.080	0.045	<0.005	0.200	0.540	1.050	No Data	No Data	No Data	6.80	110.0	1751	13.0
02-26A LYSIMETER	1987/05/10	2500.0	16.30	455.0	81.2	40.0	5140.0	337.0	1200.0	<0.100	2.830	<0.005	0.118	33.000	0.340	0.120	No Data	No Data	No Data	7.00	200.0	10932	10.0
02-51	1987/05/10	63.0	3.30	246.0	37.9	44.6	416.0	431.0	<0.5	2.300	2.010	0.006	<0.005	<0.050	<0.050	0.061	No Data	No Data	No Data	6.90	15.0	1365	11.0
02-30B	1987/05/10	300.0	40.20	134.0	20.0	82.6	554.0	462.0	<0.5	0.140	3.200	0.140	0.055	0.330	3.700	0.603	No Data	No Data	No Data	7.20	140.0	1911	11.0
02-52	1987/05/10	81.0	3.80	202.0	41.2	49.6	445.0	442.0	<0.5	2.100	2.830	0.019	<0.005	<0.050	<0.050	0.095	No Data	No Data	No Data	7.10	20.0	1463	12.0
02-36A	1987/05/10	1300.0	64.80	476.0	109.0	90.9	3500.0	684.0	129.0	<0.100	12.300	0.006	<0.005	1.240	<0.050	12.400	No Data	No Data	No Data	6.90	190.0	6831	12.5
02-45B	1987/05/10	30.0	3.00	169.0	23.4	13.0	222.0	320.0	3.4	0.120	0.154	<0.005	<0.005	<0.050	<0.050	0.024	No Data	No Data	No Data	6.70	190.0	887	11.0
02-52	1987/05/10	78.0	3.80	231.0	38.6	51.0	443.0	442.0	<0.5	2.000	2.650	0.021	<0.005	<0.050	<0.050	0.091	No Data	No Data	No Data	7.10	20.0	1463	12.0
02-42	1987/05/10	34.0	4.00	182.0	25.6	18.4	277.0	307.0	3.4	0.160	0.390	0.005	<0.005	<0.050	0.150	0.063	No Data	No Data	No Data	6.90	135.0	973	13.0
02-42	1987/05/10	34.0	4.00	182.0	25.6	18.4	277.0	307.0	3.4	0.160	0.390	0.005	<0.005	<0.050	0.150	0.063	No Data	No Data	No Data	6.90	135.0	973	13.0

^a < indicates below detection limit.

^{bc} Referenced to the calomel electrode (add 240 to convert value to Eh as referenced to the standard hydrogen electrode).